



# *Co-Located Solar and Battery Systems Perspective from GMP (Owner + Operator)*

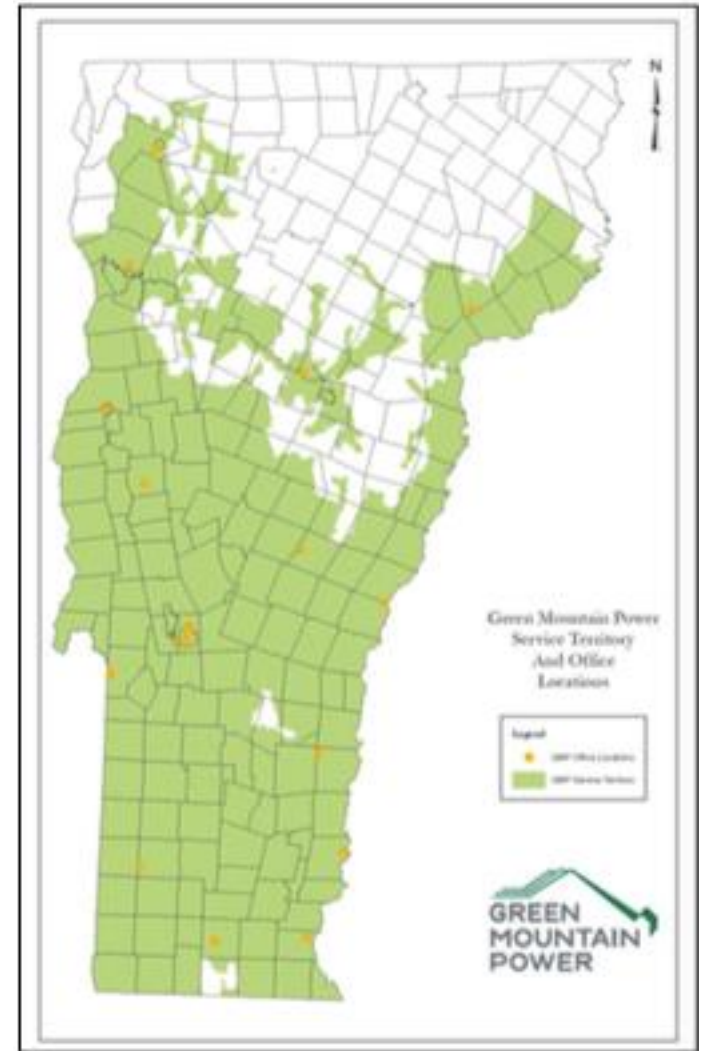


***ESIG Fall Technical Workshop  
October 14, 2021***

***Dan Belarmino  
Grid Innovation***

# Green Mountain Power

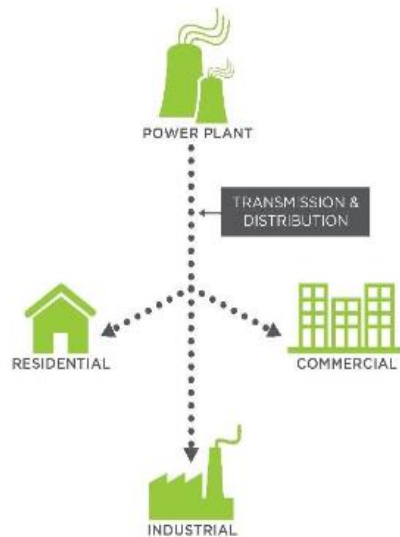
- We serve about 265,000 customers in 202 towns in 7,500 square miles of service territory
- DERs we operate:
  - 41 hydro plants units w/ total output rating of ~117 MW
  - 2 wind farms w/ total output rating of ~69 MW
  - 24 solar sites w/ total output rating of ~39MW's
  - 5 grid-scale battery energy storage system (BESS) sites w/ total output rating of ~9MW/31.4 MWH
  - All grid-scale BESS sites are co-located with solar



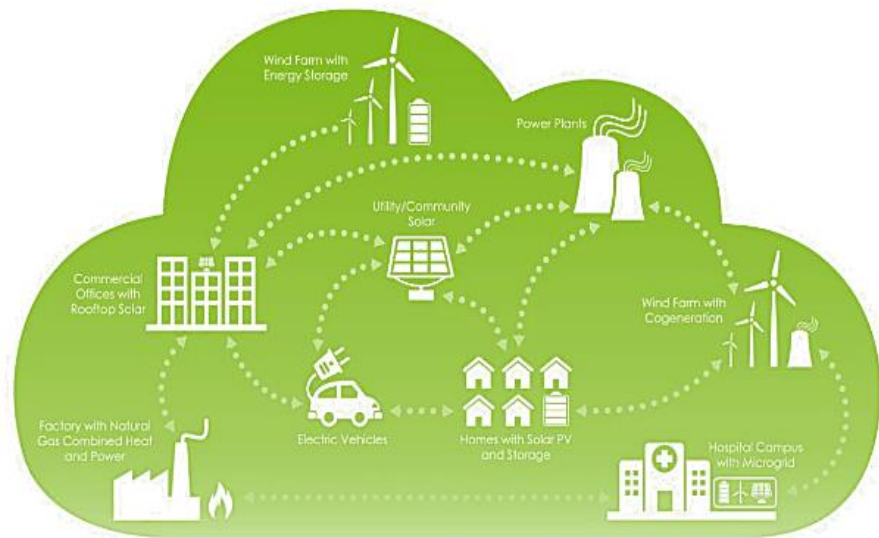
# Energy Transformation

GMP Energy Vision → 100% Renewable by 2030

**PAST:** Traditional Power Grid  
Central, One-Way Power System



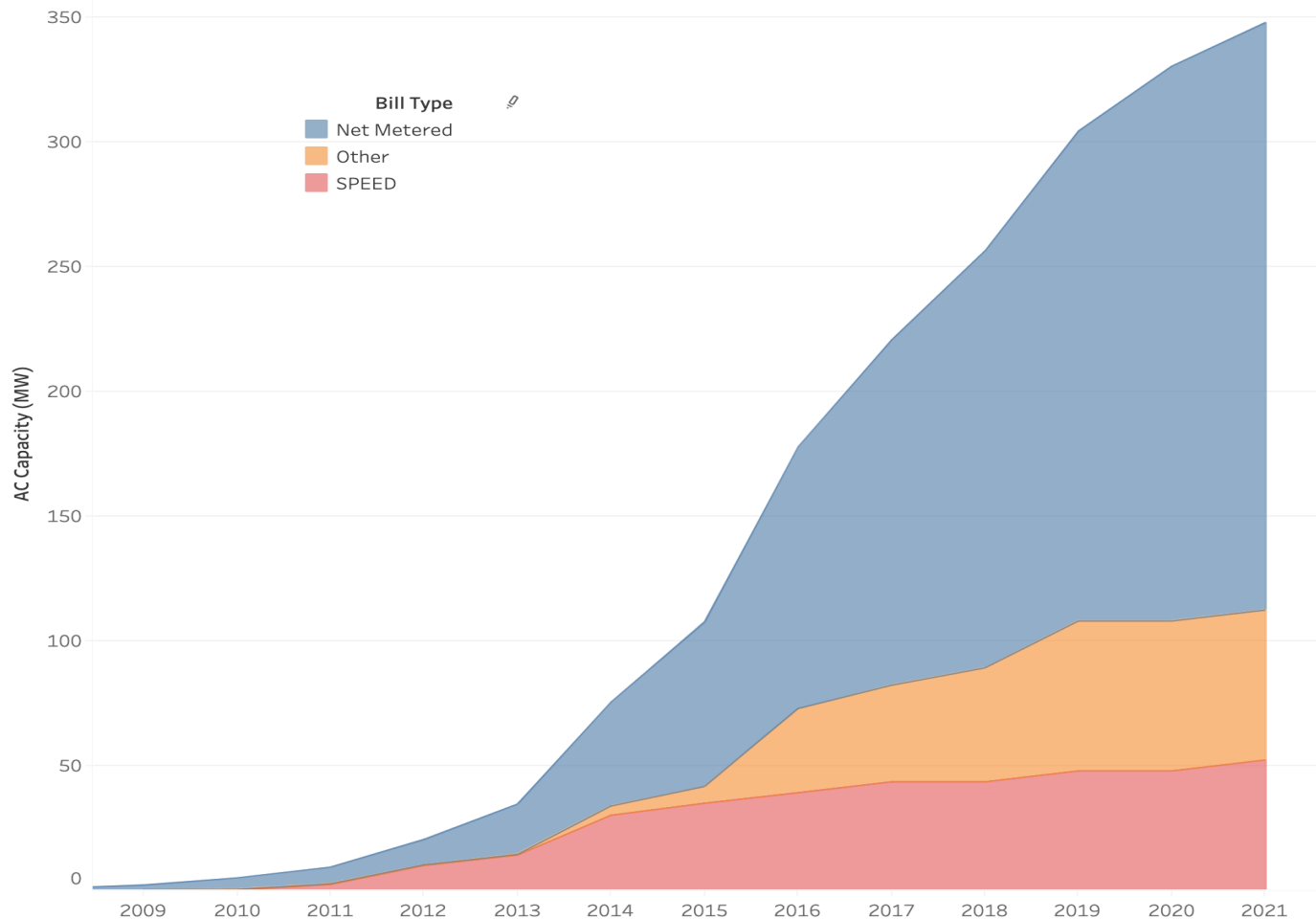
**TODAY:** The Energy Cloud  
Distributed, Cleaner, Two-Way Power Flows



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Source: Navigant

# Solar Installed Capacity in GMP



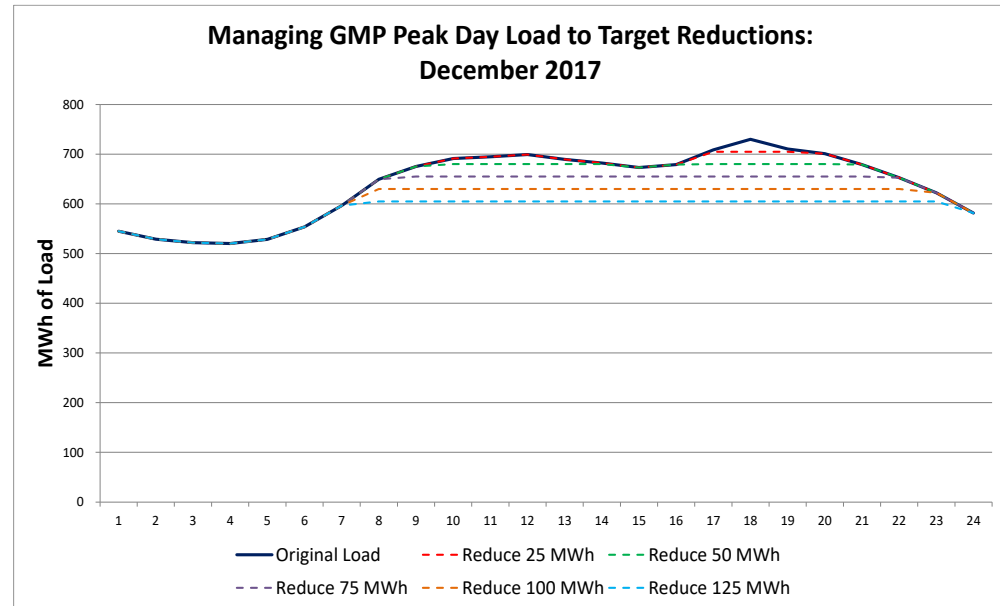
# GMP BESS Strategy

- Batteries provide a very important function that is not fully available from many other energy resources: flexibility
  - “Stacking” of several value streams (e.g., peak reduction, energy arbitrage, ancillary services, grid support)
- Battery storage systems will play critical role in reducing peak costs, as well as improving local power quality, resiliency and new ancillary market revenues to benefit our customers and drive down costs
- Help address issues of today, but dispatch can be adapted if needed to address evolving needs and market conditions



# BESS Operation To Date

- Peak Reduction
  - Forward Capacity Market
  - Regional Network Services
- Ancillary Services
  - Frequency Regulation Market





# Value of Co-Located Solar + BESS Sites



## ➤ Cost Savings

- ITC
- Interconnection cost (permitting, line upgrades, communications and controls)


## ➤ Grid Benefits

- Resiliency

# GMP Solar + BESS Sites

- Stafford Hill Project (DC-Coupled)
  - 2MW/1MWH Li-Ion and 2MW/2.4MWH Lead Acid Batteries
  - 2MW Multi-port bi-directional inverters
  - 2.5MW-DC Solar
  - Commissioned in 2015
  
- Panton Microgrid Project (AC-Coupled, no ITC)
  - 1MW/4MWH Tesla Powerpack
  - 4.99 MW-AC Solar
  - Commissioned in June 2018
  
- Essex, Milton, and Ferrisburgh Microgrid Projects (AC-Coupled, with ITC)
  - 2MW/4MWH Tesla Powerpack
  - 4.99 MW-AC Solar
  - All three sites were commissioned in October 2019

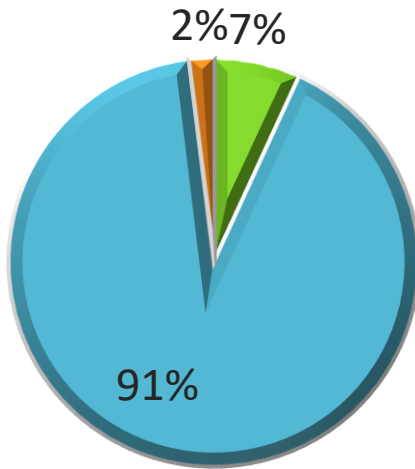




# **DC-Coupled and AC-Coupled Sites Operation Strategy**

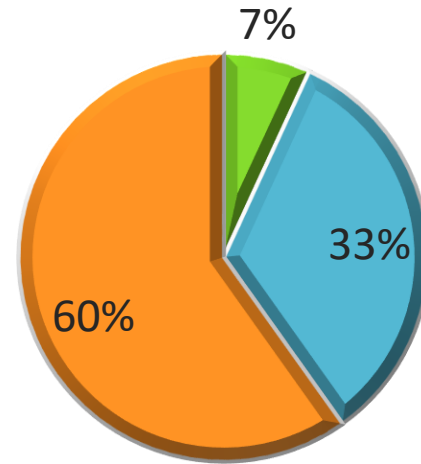
# BESS Operation (no ITC)

AC-Coupled BESS  
% Hours of Operation per Year



*Pantan Site*

DC-Coupled BESS  
% Hours of Operation per Year



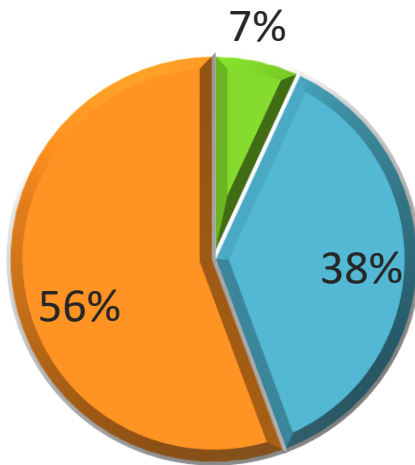
*Stafford Hill Site*

■ Peak Reduction ■ FRM ■ Other

■ Peak Reduction ■ FRM ■ Other

# BESS Operation (with ITC)

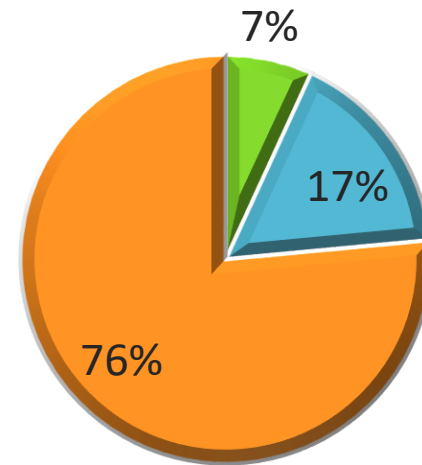
AC-Coupled BESS  
% Hours of Operation per Year



*Essex, Milton, and Ferrisburgh sites*


■ Peak Reduction ■ FRM ■ Other

DC-Coupled BESS  
% Hours of Operation per Year



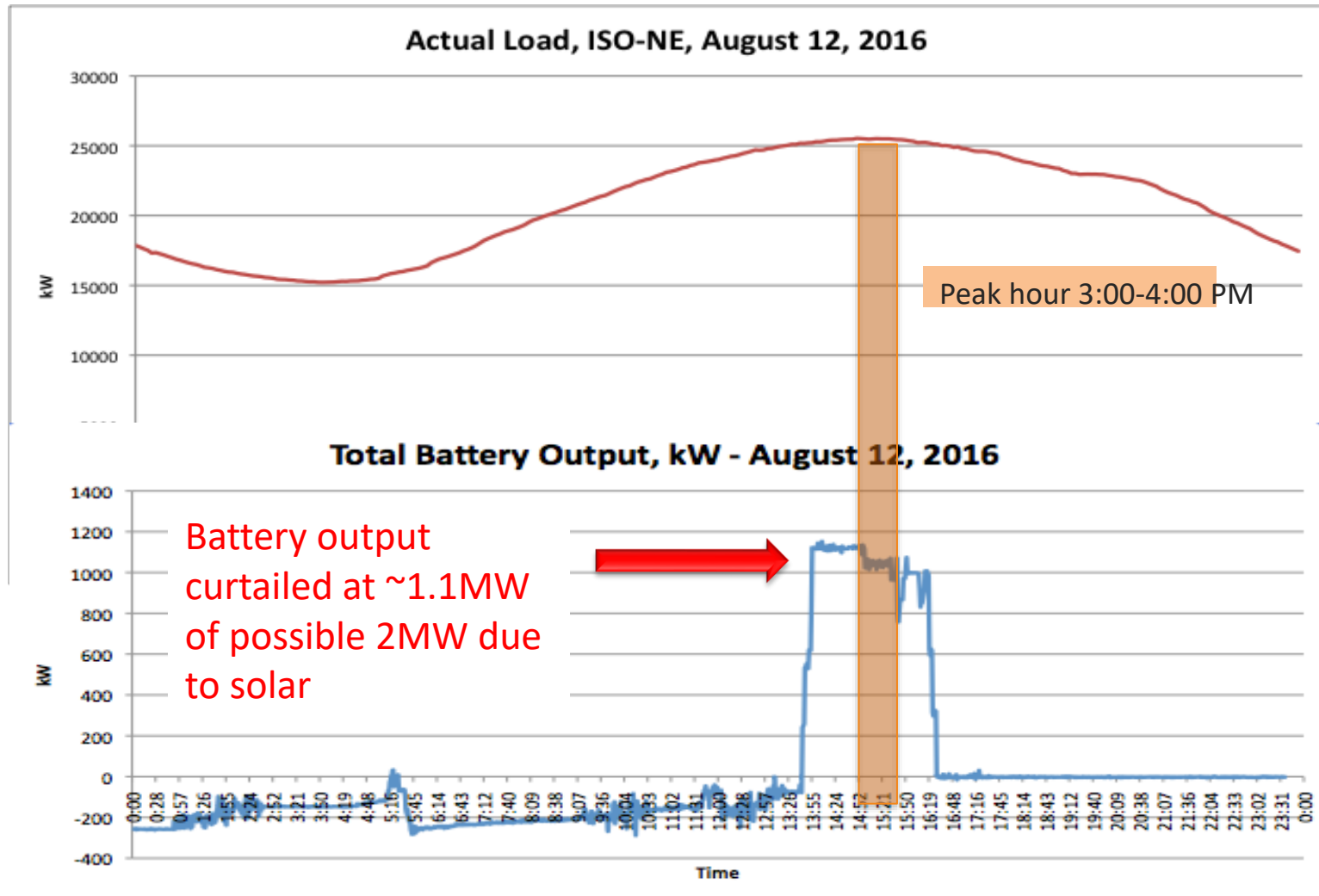
*Estimated operation based on FRM dispatch strategy with AC-Coupled BESS with ITC*

■ Peak Reduction ■ FRM ■ Other



# **DC-Coupled Peak Reduction Performance and Savings**

# Stafford Hill Peak Reduction Performance





# Missed FCM Peak Reduction Savings

- GMP estimates the FCM peak reduction savings is based on the auction price, reserve margin, and assumed transmission losses.
- For each MW of FCM peak reduction, the calculated savings is roughly \$100,000 per year.
- Stafford Hill at 2MW BESS output capacity, the maximum savings in 3 years is \$600,000

Year	Stafford Solar Output (KW)	BESS Missed Peak Reduction Savings
2019	988	\$98,800
2020	233	\$23,300
2021	450	\$45,000
<b>Total</b>		<b>\$167,100</b>



# **Frequency Regulation Market (FRM) Summary**

# FRM Operation and Revenue

- Panton Site (AC-Coupled and no ITC) FRM performance:
  - The total revenue in 2019 and 2020 is **\$418,328**
  - Panton participated in the FRM for approximately 333 days per year
- Using Panton's revenue as baseline:
  - If Stafford participated in FRM in 2019 and 2020, the maximum calculated FRM revenue is approximately **\$152,000**



# Resiliency

# Distribution Islanding





# Takeaway

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- Solar and BESS are key to Grid Transformation and GMP's Energy Vision
- Co-located Solar and BESS sites provides significant installation cost savings and grid resiliency opportunities
- AC-coupled sites are preferred over DC-coupled sites due to operational flexibility
  - Results in higher peak reduction savings and FRM revenue

# Thank You

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